

SAR in Ice Operations: the NIC and CIS Experience

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Michael Manore

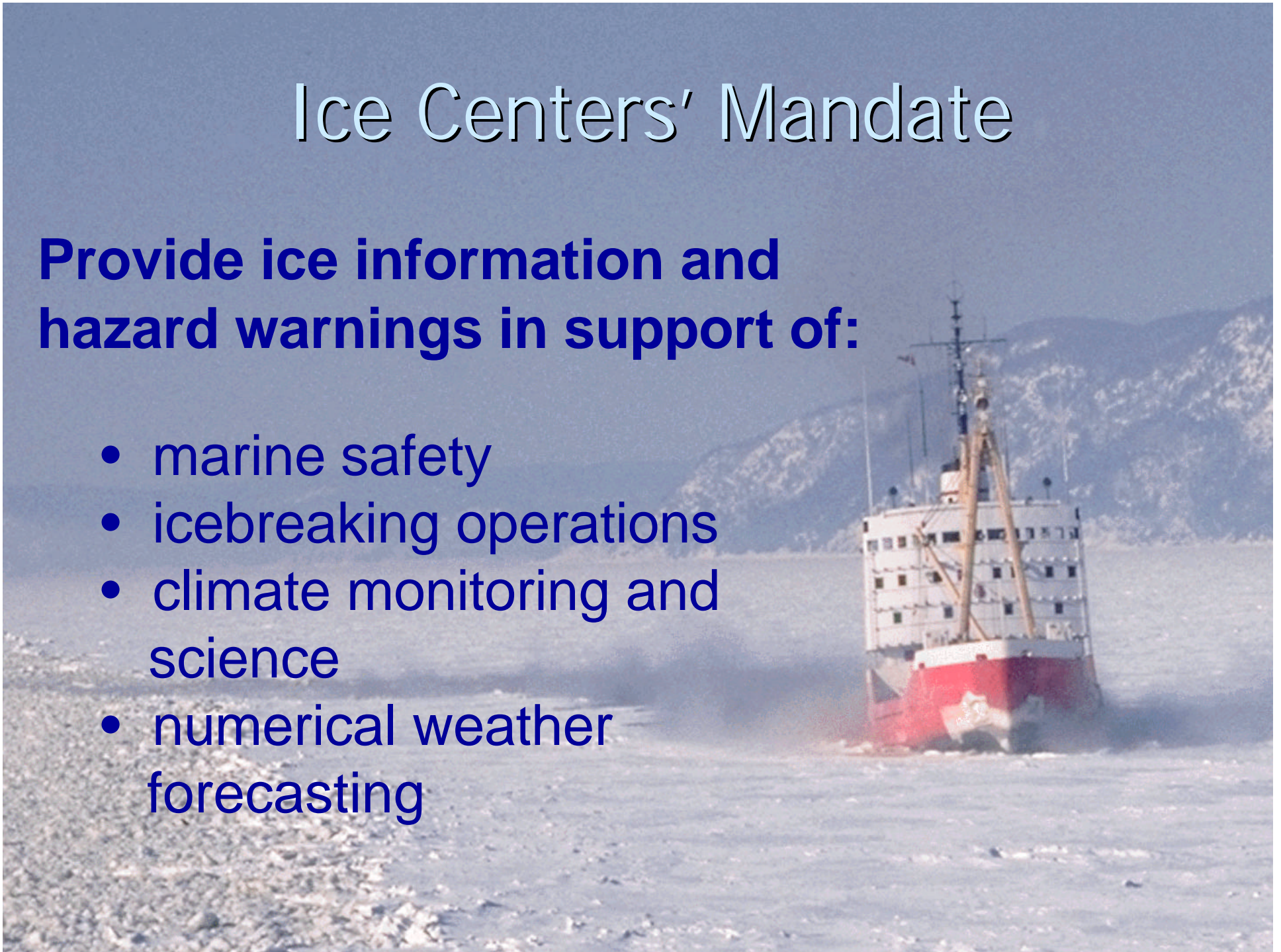
Chief, Strategic Planning
Canadian Ice Service



Ice Centers' Mandate

Provide ice information and hazard warnings in support of:

- marine safety
- icebreaking operations
- climate monitoring and science
- numerical weather forecasting



Ice and SAR

SEASAT

- Operational potential demonstrated early
 - Aircraft SAR, SEASAT ('78), SIR-A,B ('81-4)
- Experience gained with satellite SAR through ERS AO and operational data
- First wide-swath SAR from RADARSAT-1
 - "free" data to USG through US allocation
 - CIS/NIC data exchange
- Data continuity required for future operational use
 - ENVISAT, ALOS, RADARSAT-2, US program (?)



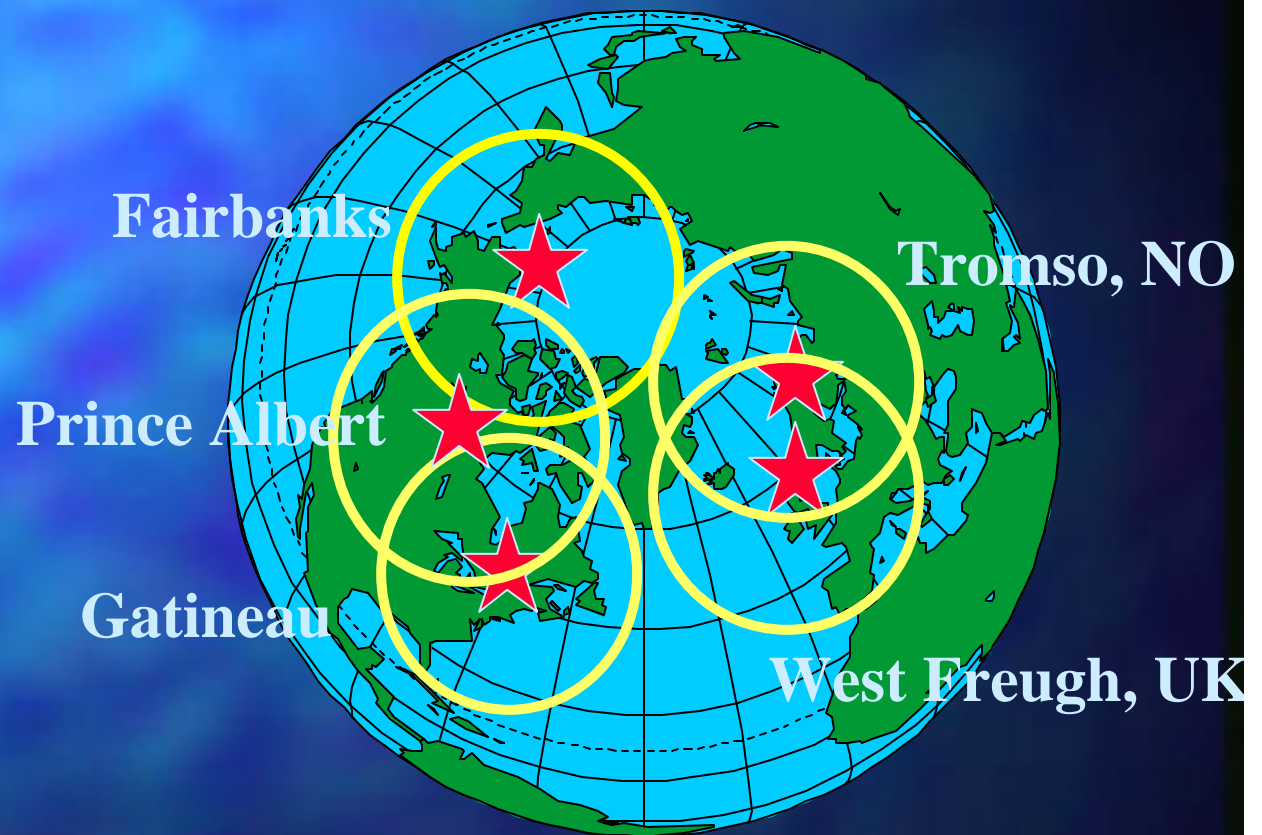
RADARSAT Data Acquisition

**Near Real Time
Image Acquisitions
(avg. per year):**

NIC ~ 4000 images

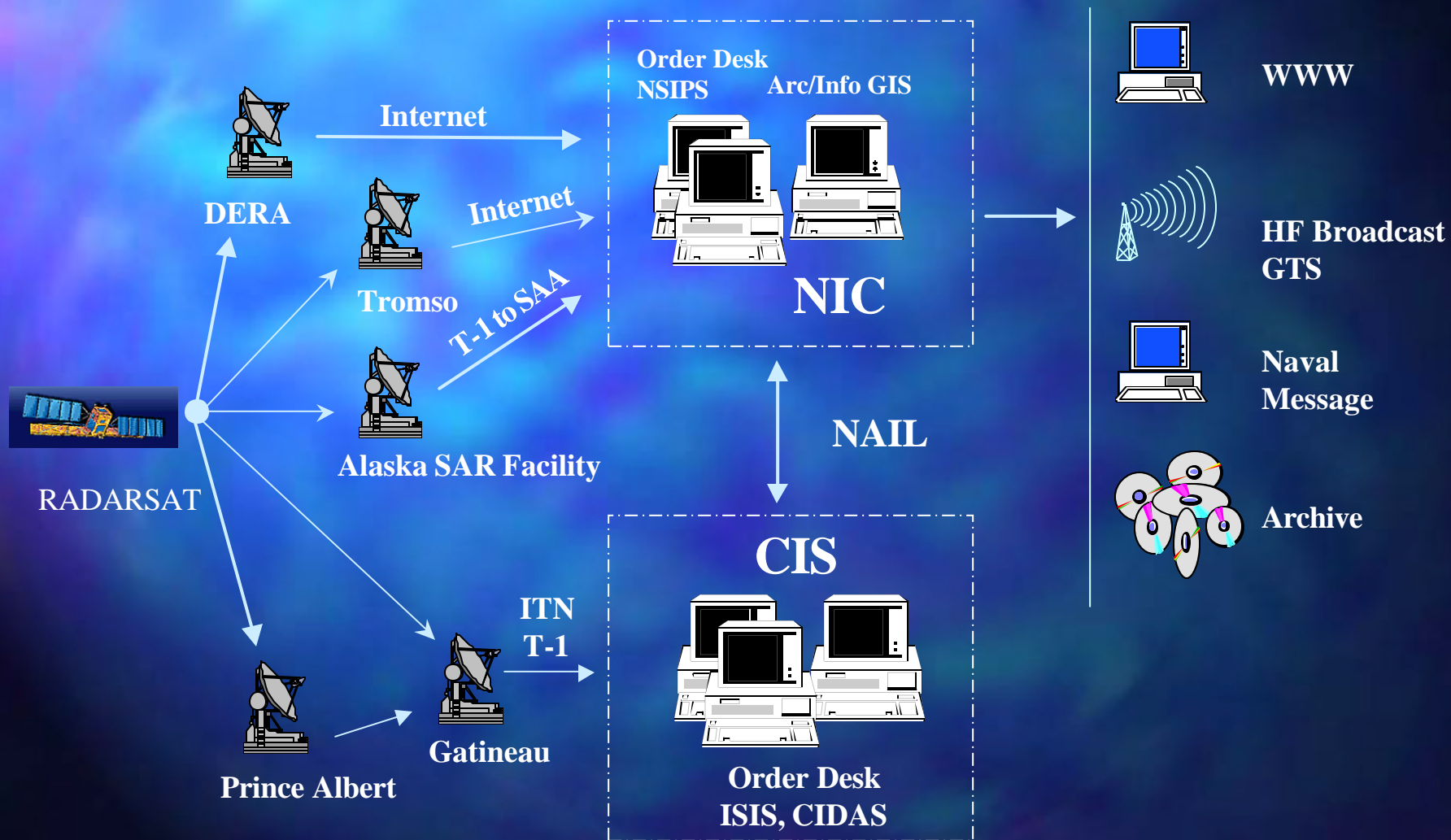
CIS ~ 4500 images

Overall ice services
usage estimated at
10,000 images/yr



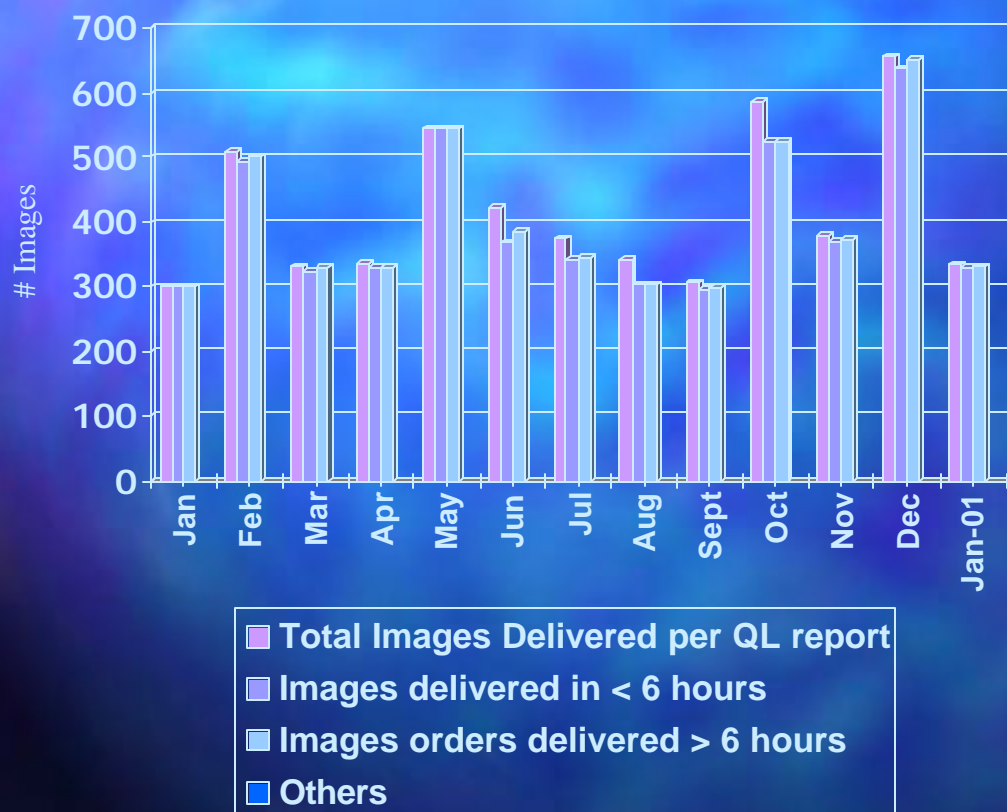


Data Reception and Communications





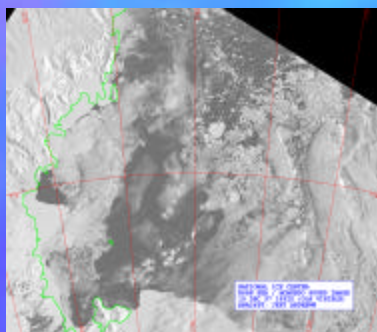
ASF Quicklook Report 2000 - 2001



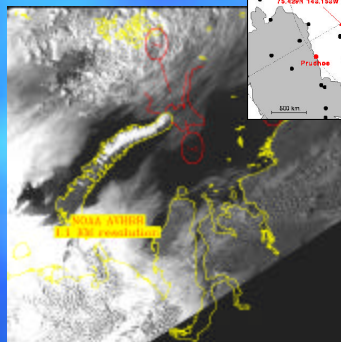
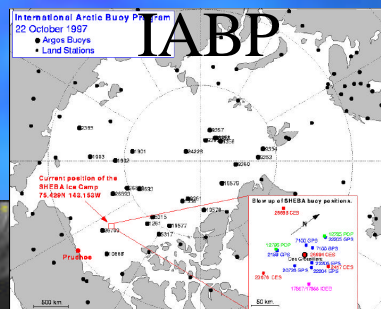
- For January 24, 2000 to January 25, 2001
- Median Delivery Time: 2 hours 23 min
- Average Delivery Time: 3 hours 13 min
- Range: 1:01 to 5:00 hours



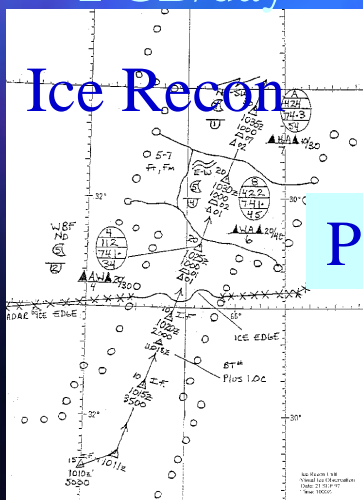
Sea Ice Products: the Analysis Process



DMSP OLS
2 GB/day

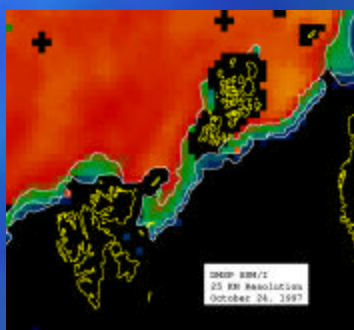
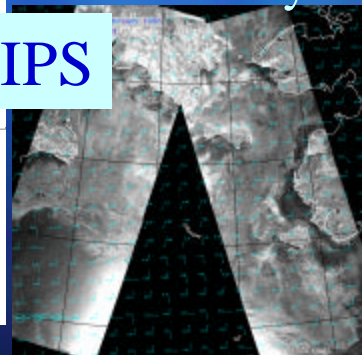


AVHRR
2 GB/day



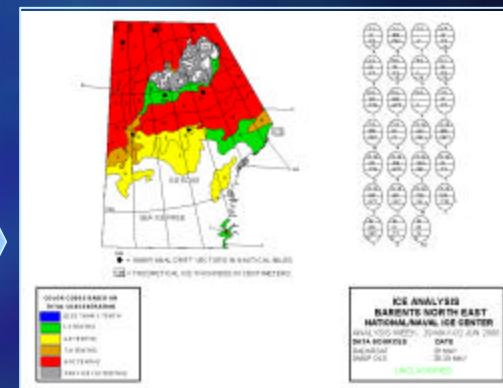
Ice Recon

PIPS

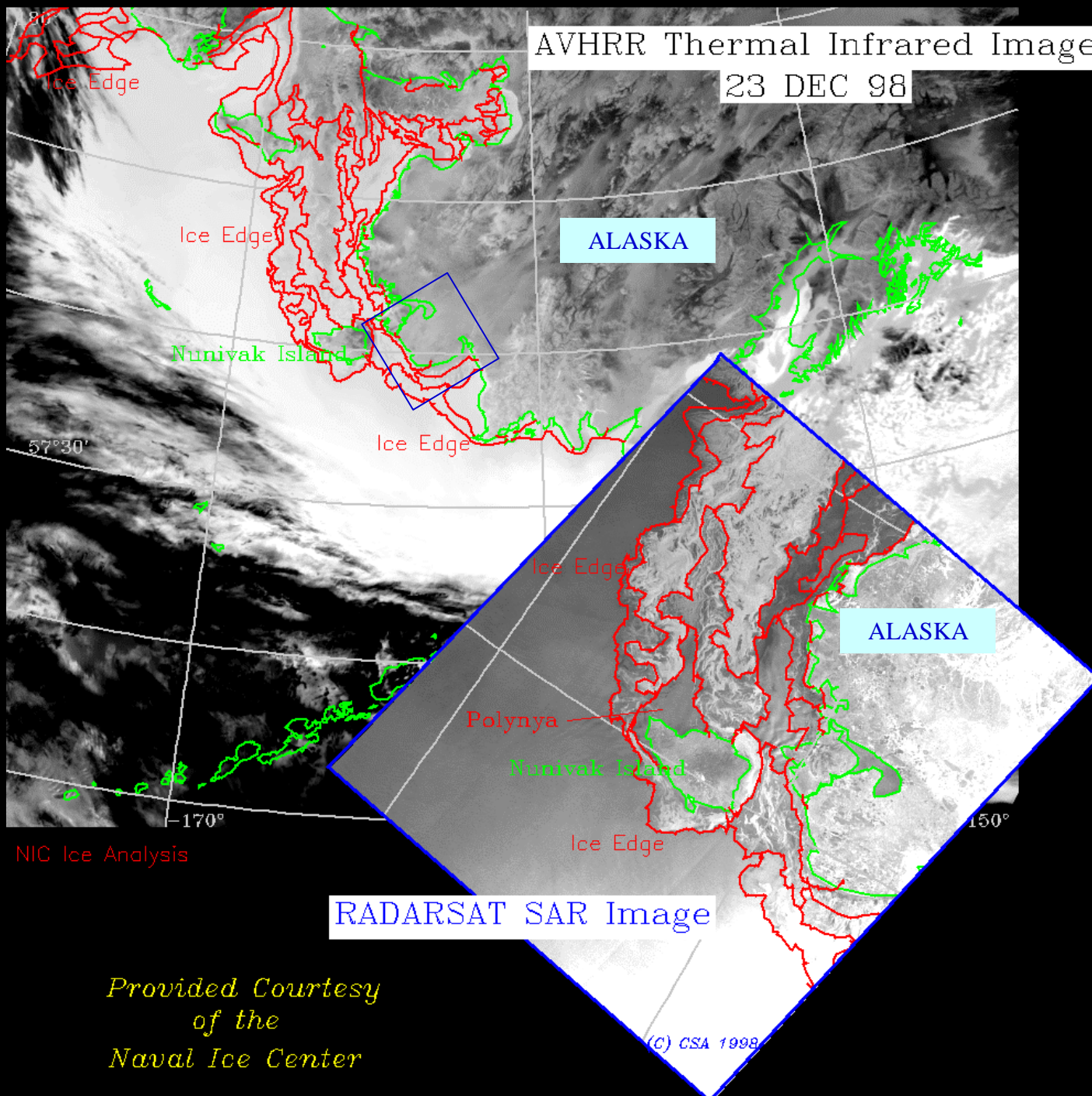


DMSP SSM/I

RADARSAT
0.8 GB/day



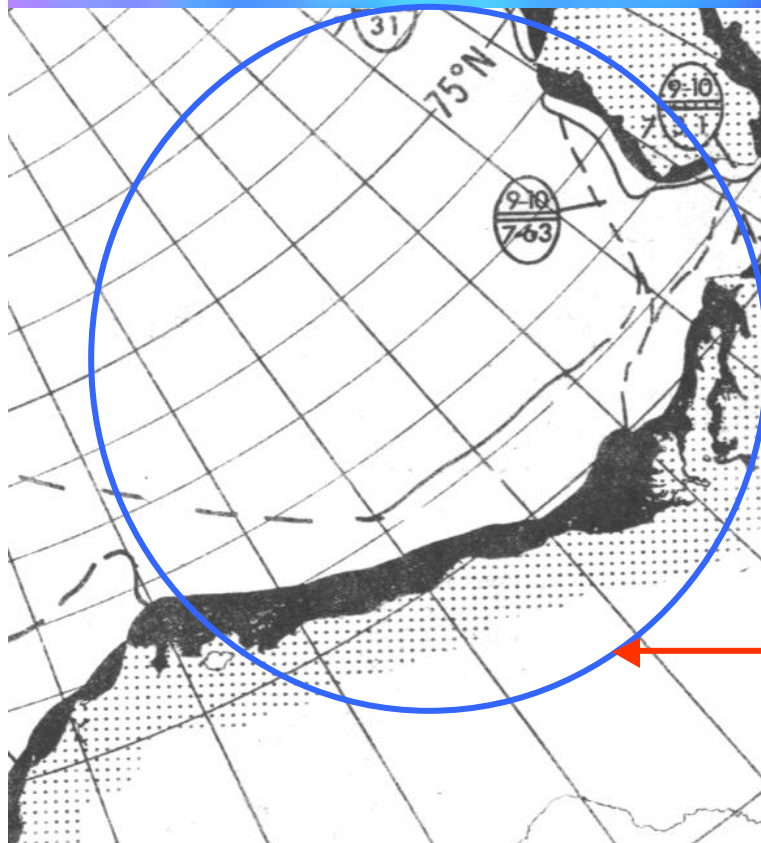
Ice chart



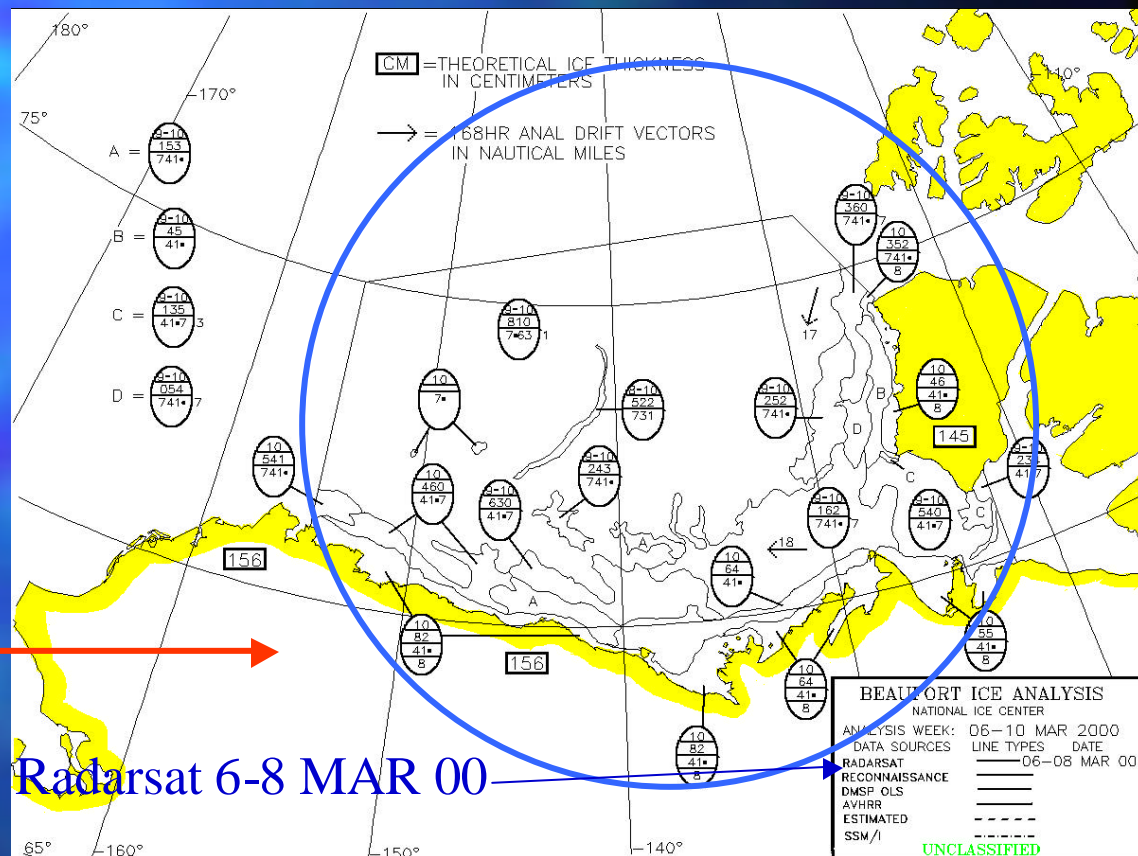
*Provided Courtesy
of the
Naval Ice Center*



SAR and NIC Ice Charts



Beaufort Sea
1992

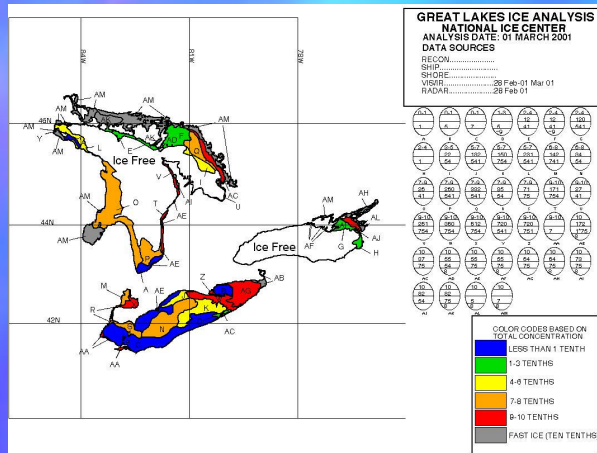


Radarsat 6-8 MAR 00

Beaufort Sea
2000

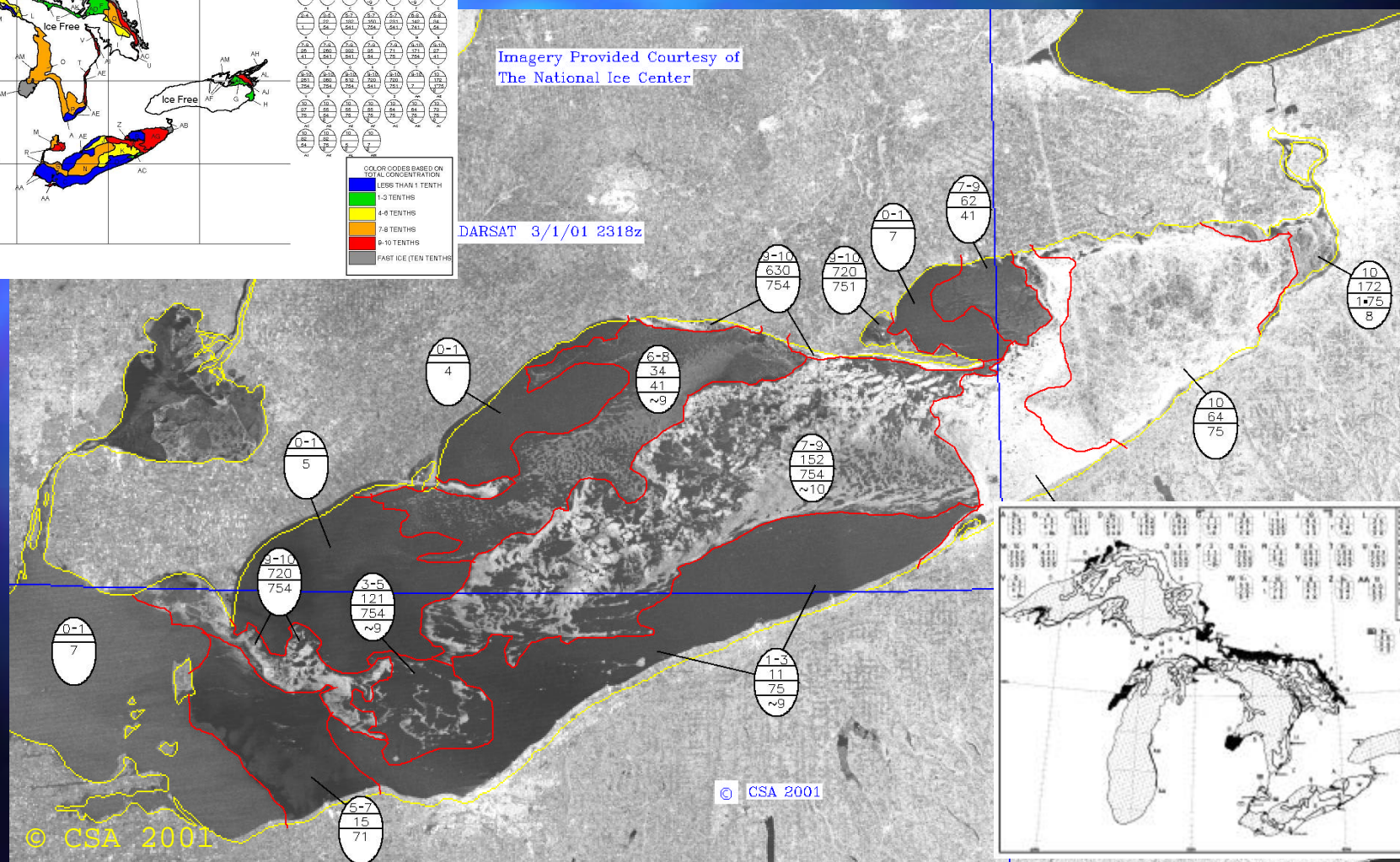


Great Lakes OPS



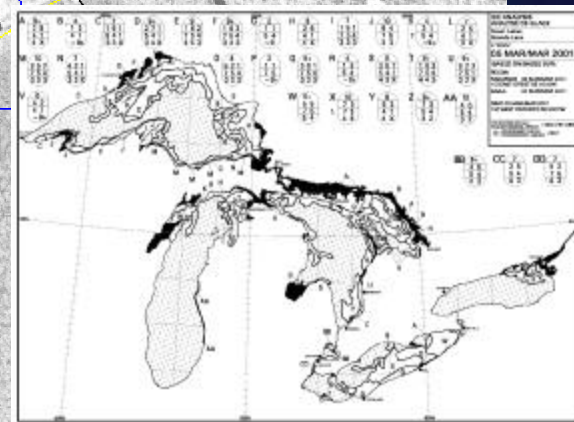
Imagery Provided Courtesy of
 The National Ice Center

DARSAT 3/1/01 2318z



© CSA 2001

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Annotated Imagery Products

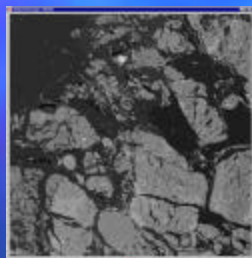




Radar tools

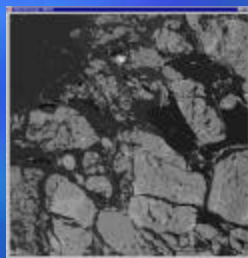
Current Situation

Radarsat



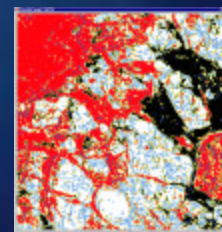
Future Situation

Radarsat



Batch tools

Ice classification

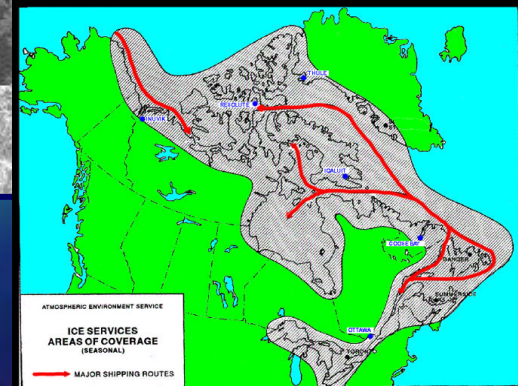
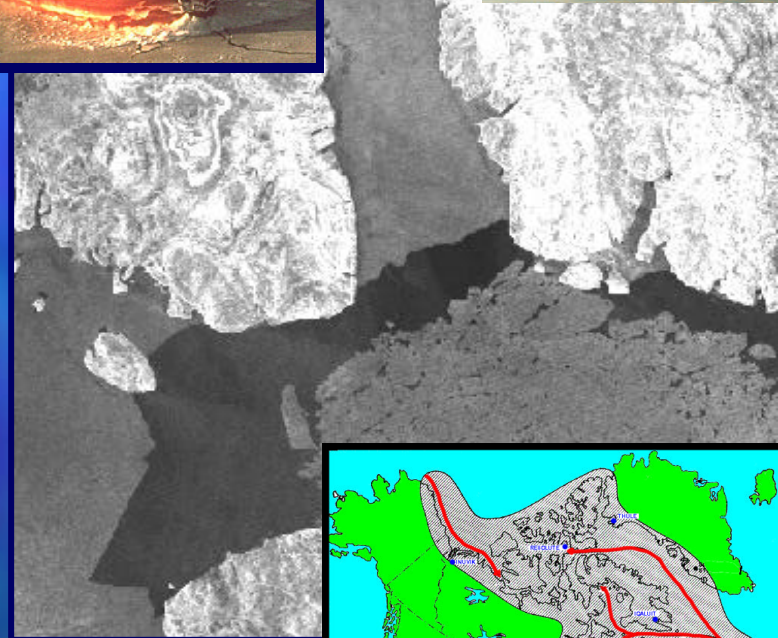


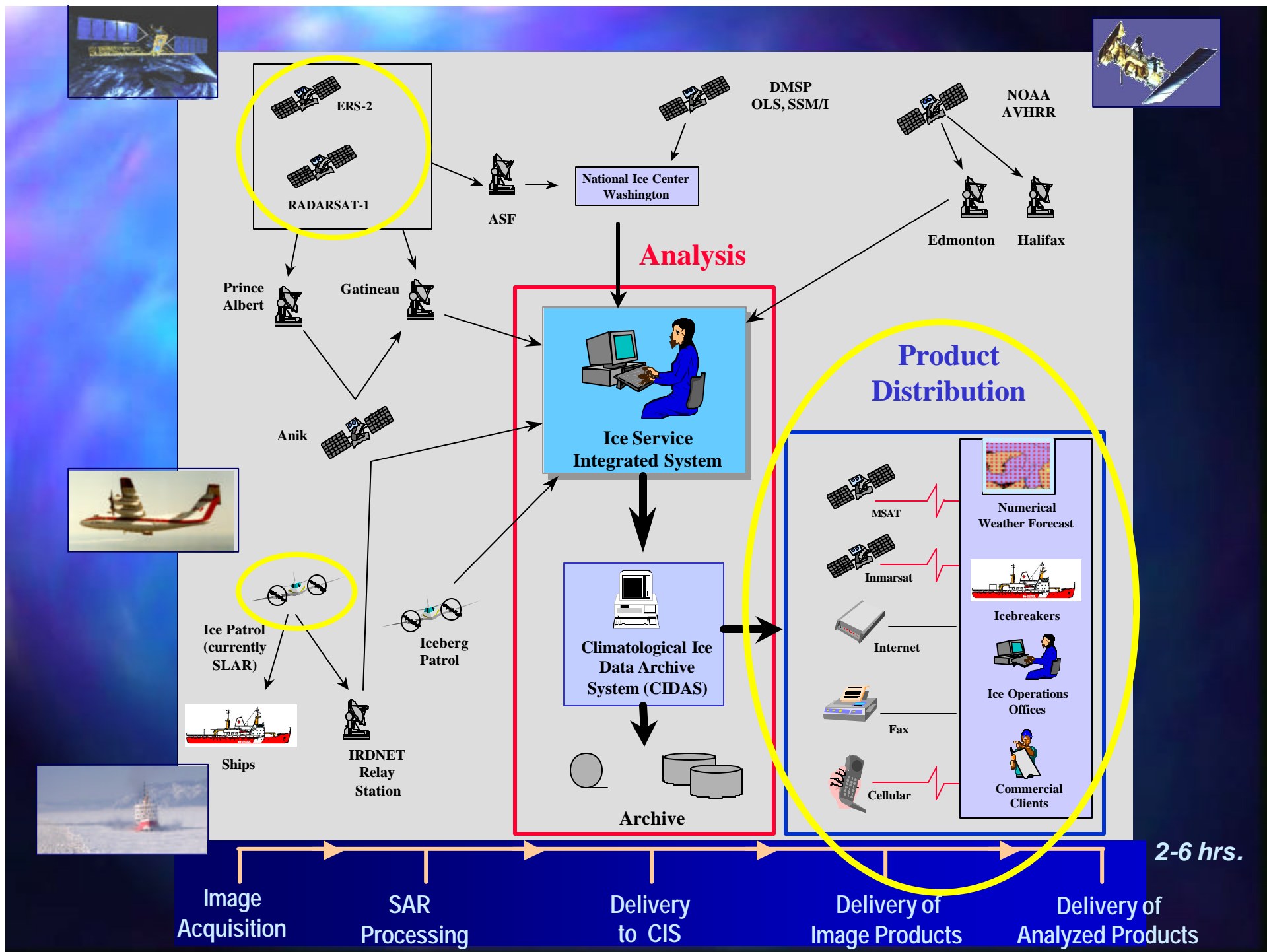


Canadian Ice Service



- Unit of the Meteorological Service of Canada
- Ice analysis methods similar to NIC
- Major Client/Partner - Canadian Coast Guard (CCG)
 - Cost-shared program
 - unique services include:
 - aircraft reconnaissance
 - field personnel on CCG vessels







Challenges in Product Distribution

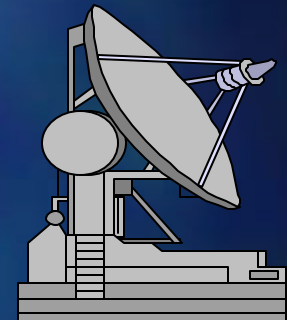
- Near-real-time information requirement
- Wide variety of products and client capabilities
 - e.g., text bulletins, paper charts/fax, digital data
- Limited and/or expensive marine telecom links
- Large data volume for imagery
 - e.g., 1 RADARSAT image = 100+ MB
- Integration with other analysis, navigation tools
 - product formats
 - integration with other data sources (e.g. GPS, ECDIS)





Solutions

- Exploit most cost-effective option for user
 - e.g., fax, HF-fax, Internet, Email, ftp, cellular, INMARSAT
- Use limited set of common data formats
 - e.g., GIF, ARC/INFO, others
- Data reduction
 - resolution or area of coverage
- Data compression
 - e.g., 15:1 wavelet-based compression for RADARSAT
- Continual assessment of new options
 - Internet vs. dedicated links
 - high-bandwidth satellite TV equipment

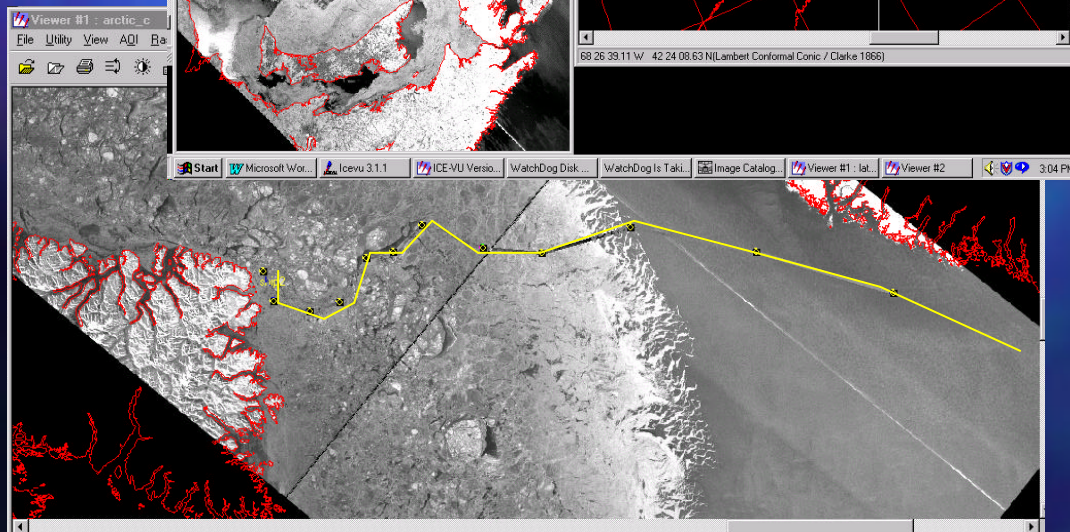
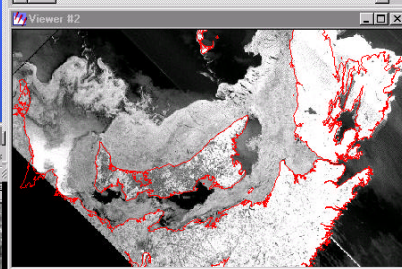
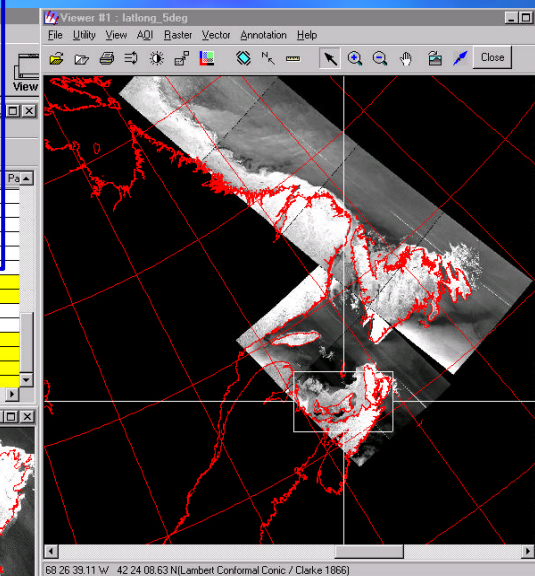




Ice-VU Shipboard Display



38	0321-2155-northumbria_rn.sid	c:/data/mrsl/
38	0321-2155-anticosti_e_rn.sid	c:/data/mrsl/
38	0321-2155-anticosti_e_rn.sid	c:/data/mrsl/
38	0321-2158-cnt_lab_coast_rn.sid	c:/data/mrsl/
4	0322-2126-avalon_pen_rn.sid	c:/data/mrsl/
4	0322-2127-belle_isle_rn.sid	c:/data/mrsl/
4	0322-2128-cnt_lab_coast_rn.sid	c:/data/mrsl/
4	0322-2129-n_lab_sea_rn.sid	c:/data/mrsl/



- Integrated telecom and product display
 - charts
 - aircraft
 - satellite
- Route planning tools
- Links to ship GPS
- Ice information in ECDIS still under development



Observations

- Fully operational use of satellite SAR is proven in both ice services
 - adopted by several international ice services on commercial imagery basis
- Factors of Success
 - high information content for ice monitoring
 - reliable near-real-time image delivery
 - investment in telecom infrastructure
 - investment in training in use of SAR
- Model for other near-real-time applications
 - e.g., Disaster Monitoring, Coastal Surveillance



Challenges

- High-reliance on labor-intensive, visual interpretation
 - absence of automated algorithms has not prevented operational adoption
- Product dissemination
 - limited, expensive marine communications
 - address through data compression, emerging telecom technologies
- Continuity of data
 - multiple satellites desirable for improved temporal coverage, operational redundancy, long-term data continuity



Future Plans

- Ensure affordable access to data from new SARs
 - ENVISAT and ALOS AO projects (NIC, CIS, JPL)
 - operational use of ENVISAT, RADARSAT-2, ALOS
- Increase international cooperation
 - International Ice Charting Working Group (IICWG)
 - data access, training, archives, collaborative R+D
- Continue automated algorithm development
 - NIC and CIS with U. Kansas, JPL, others
- Introduce automated algorithms to the operations floor

